08/961929

5963329

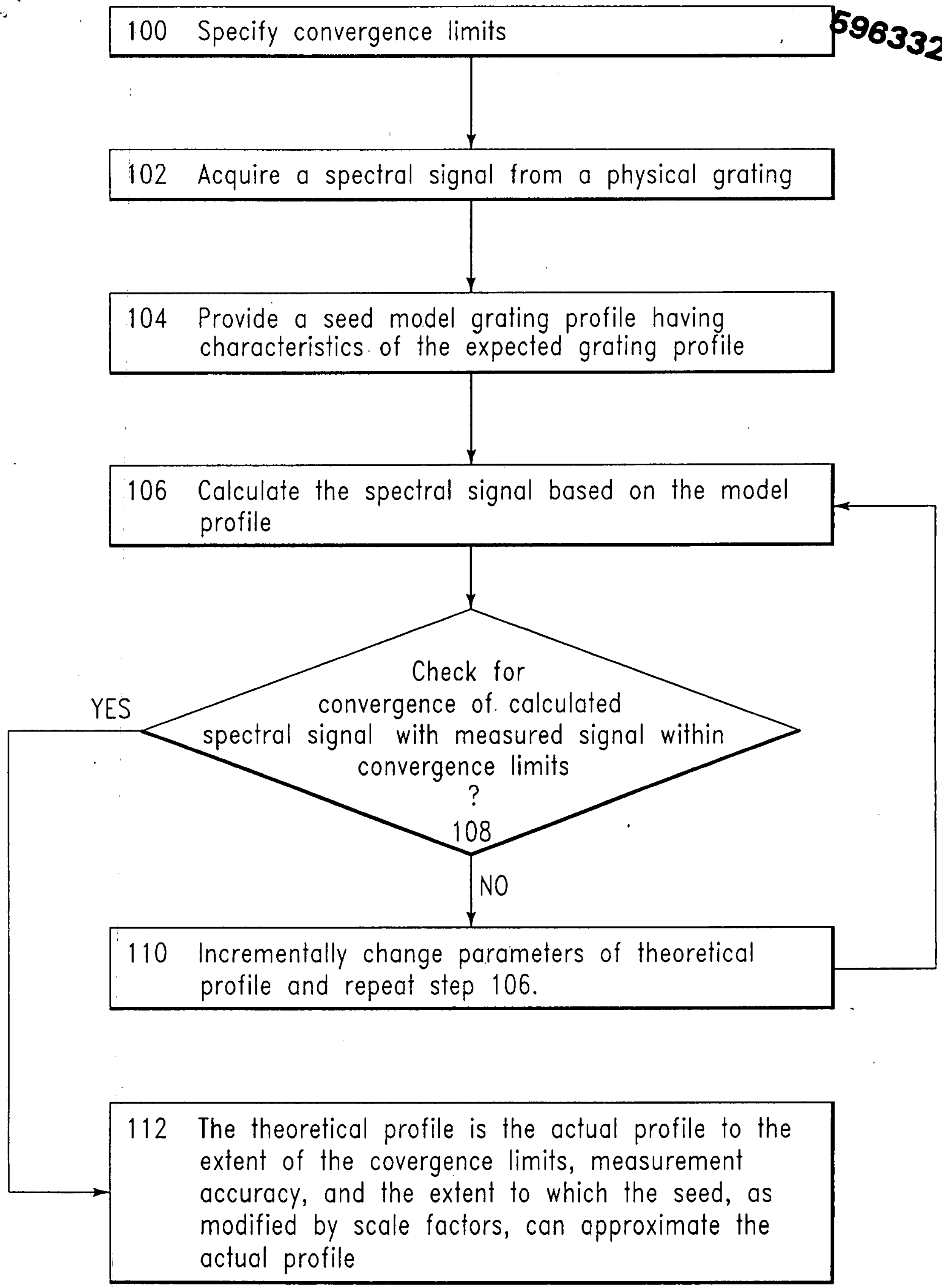


FIG. 1

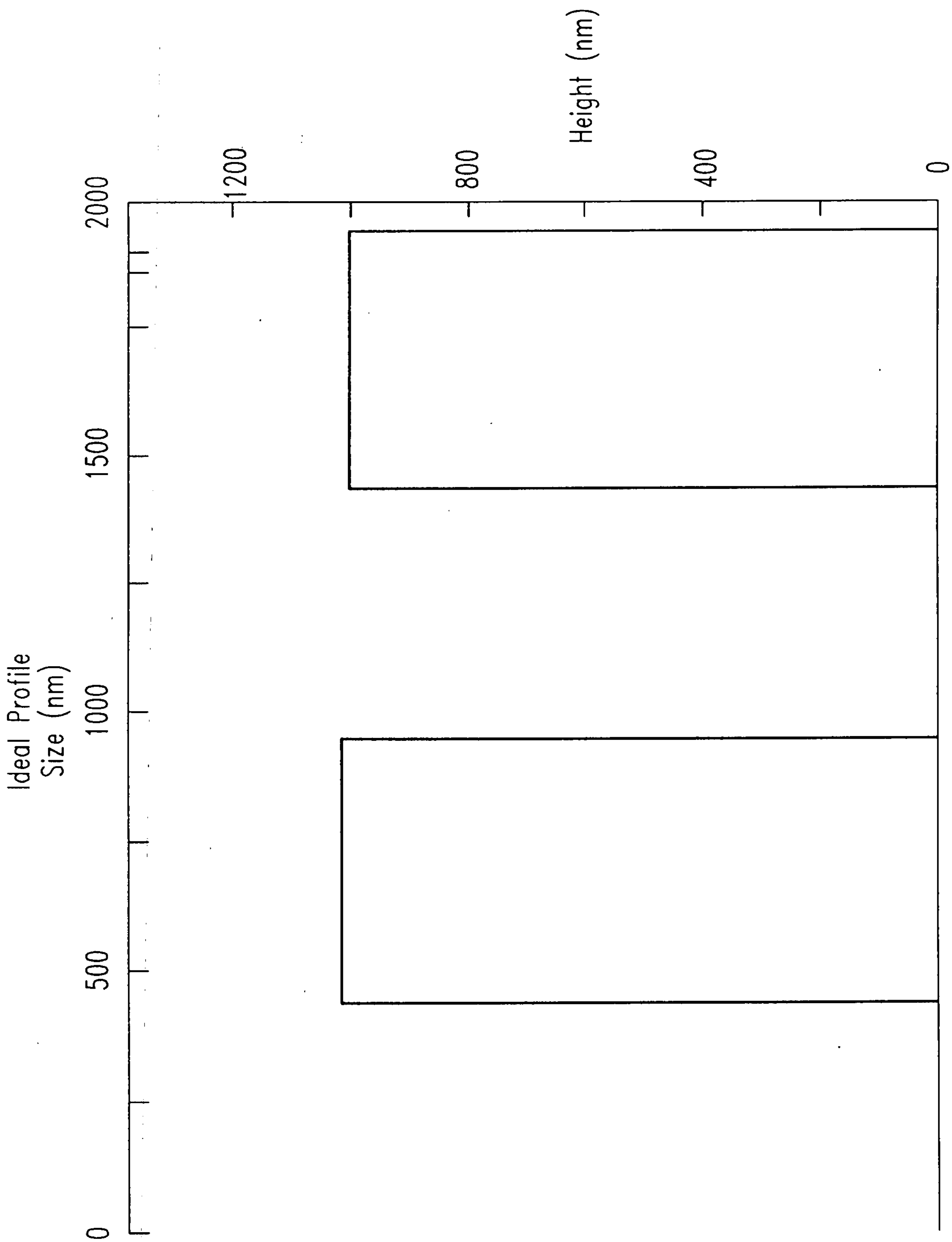

Height (nm)
1200
800
400
0
2000
1500
1000
500
0
Ideal Profile
Size (nm)

FIG. 2

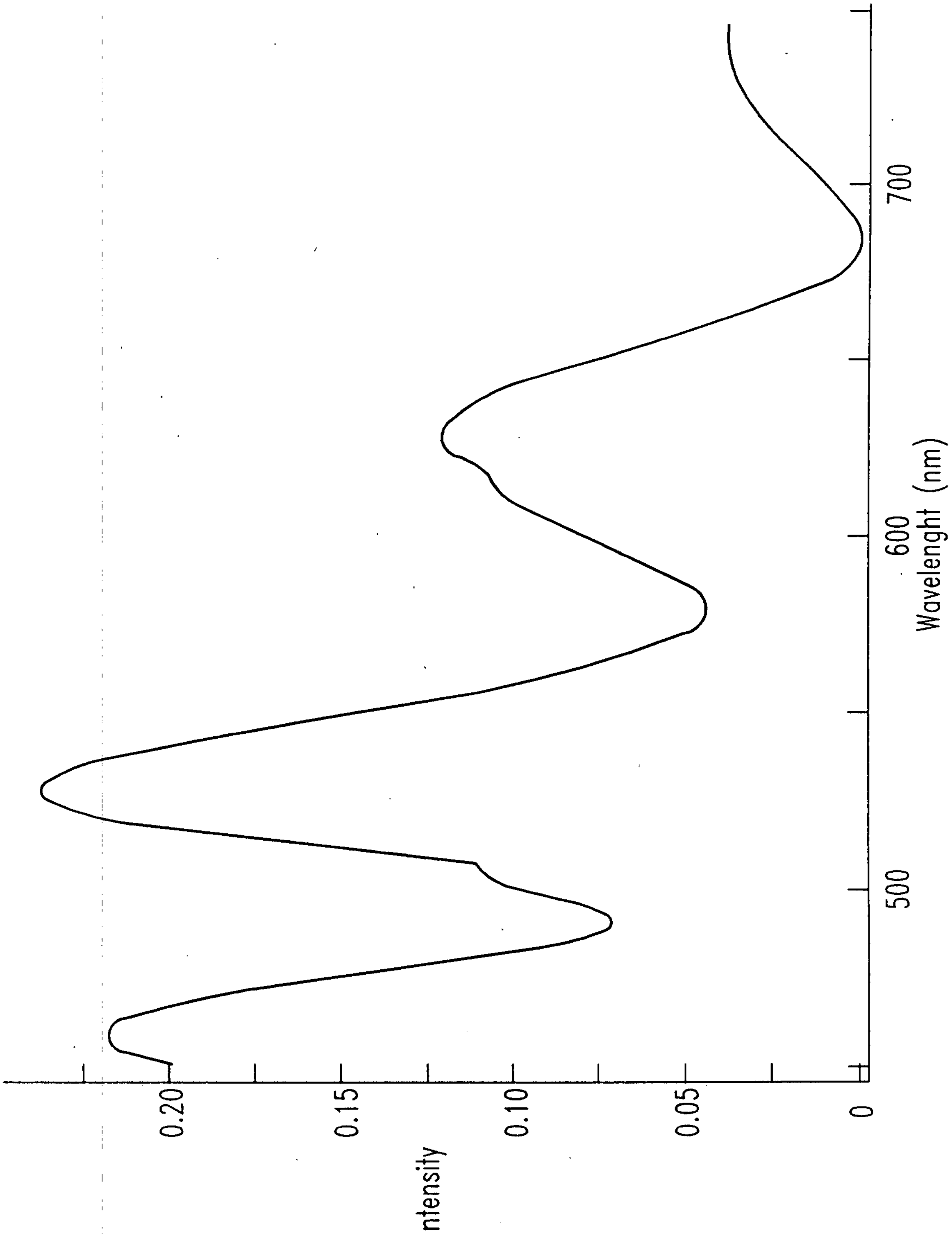


FIG. 3

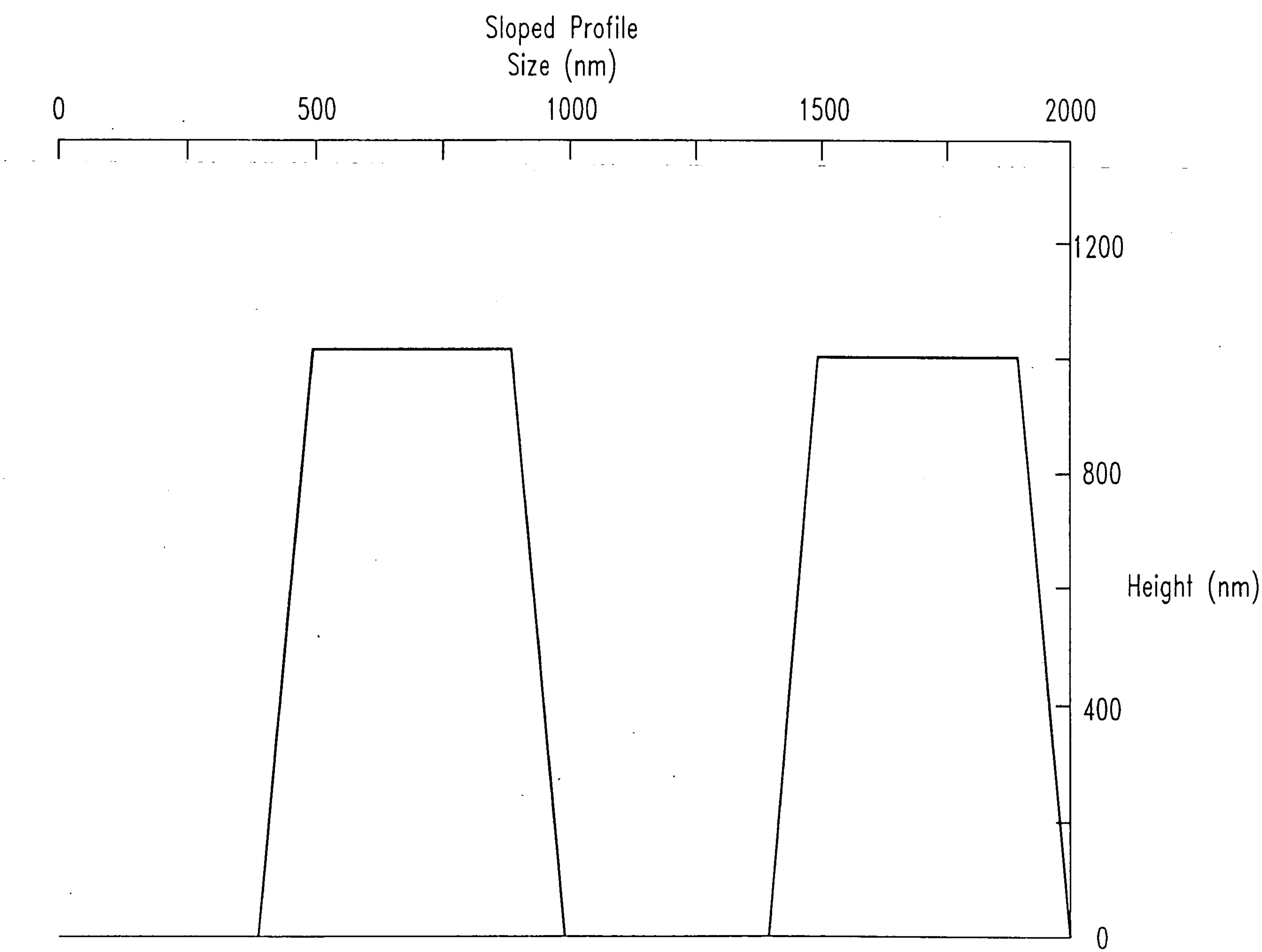

Sloped Profile
Size (nm)
0
500
1000
1500
2000
1200
800
400
0
Height (nm)

FIG. 4

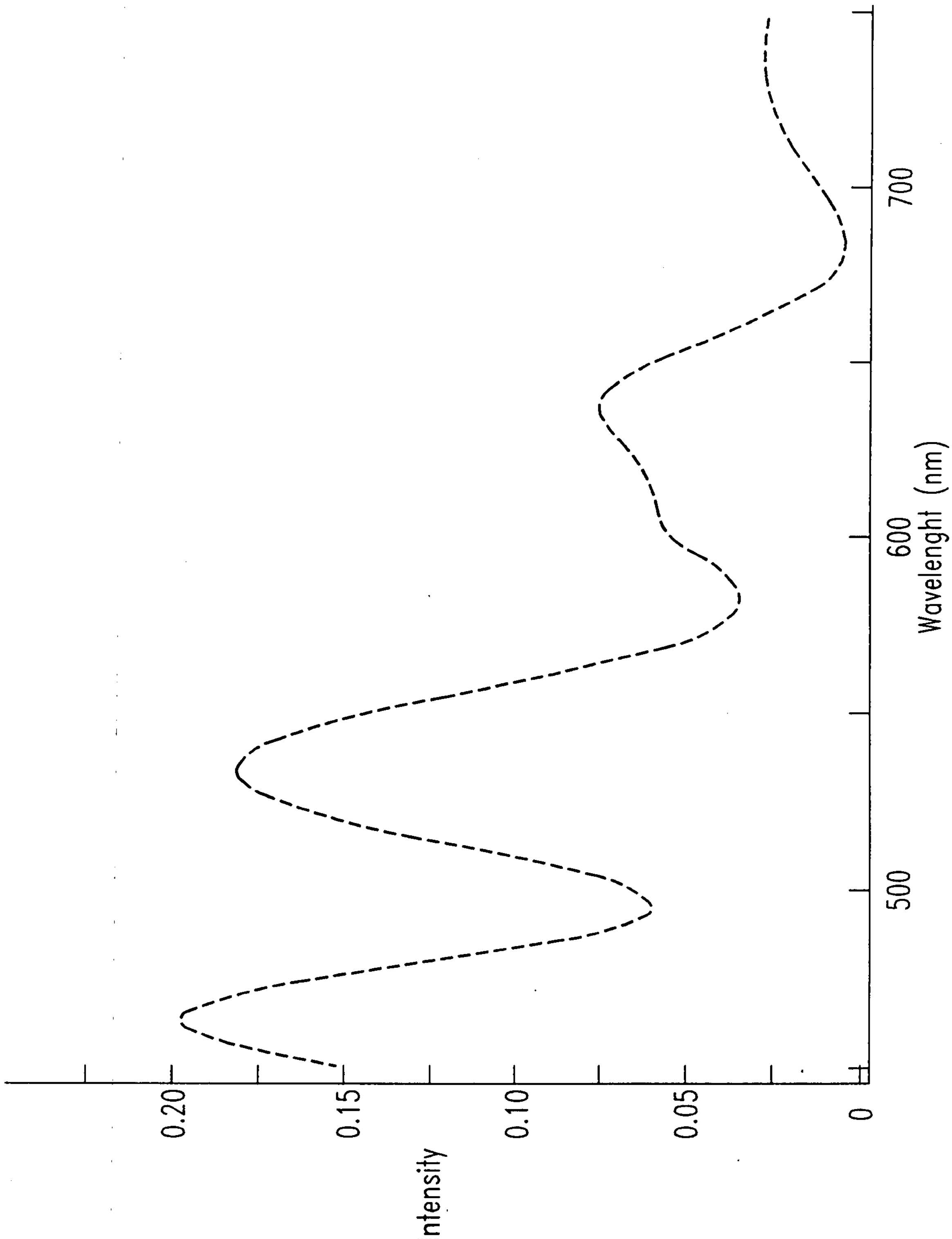


FIG. 5

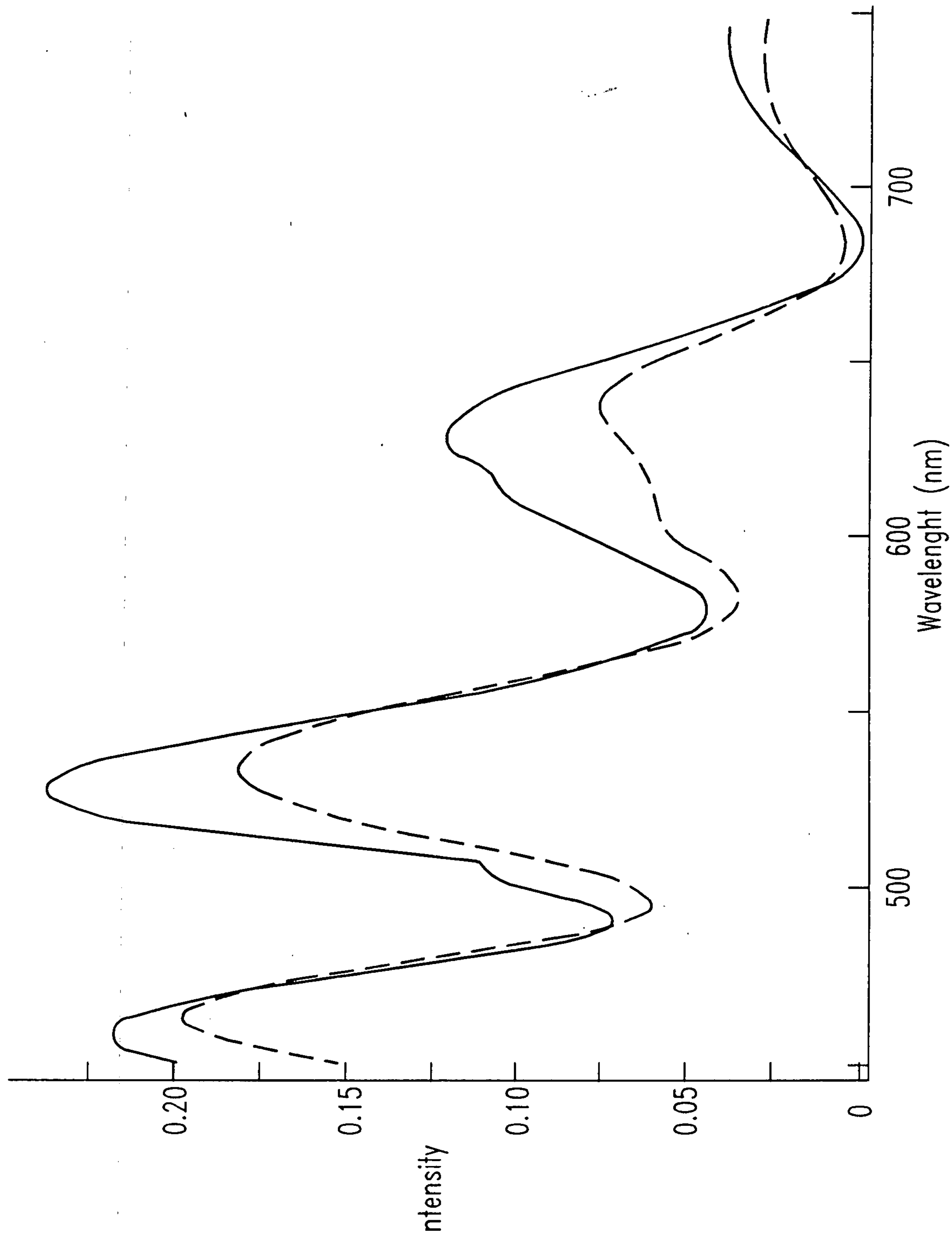


FIG. 6

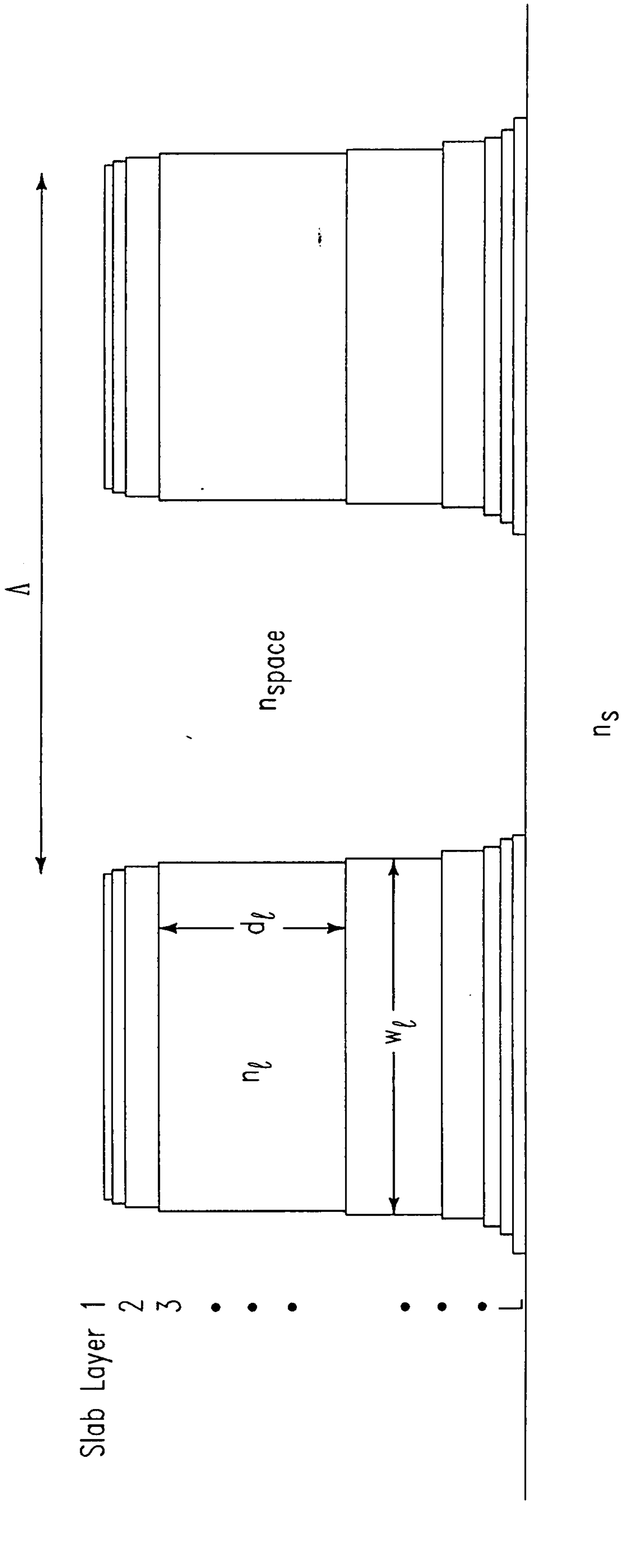


FIG. 7

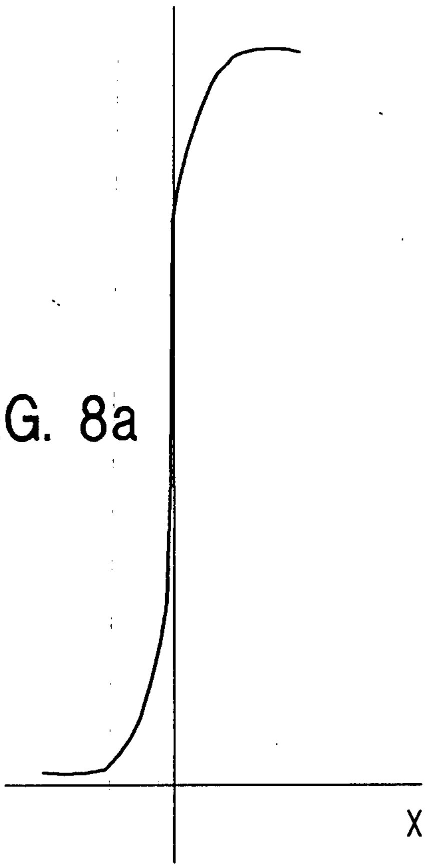


FIG. 8a

FIG. 8b

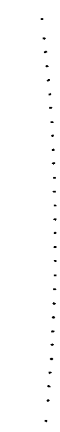


FIG. 8c

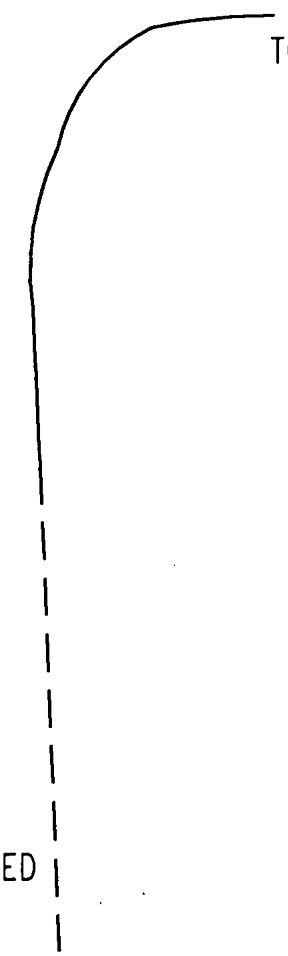


FIG. 8d

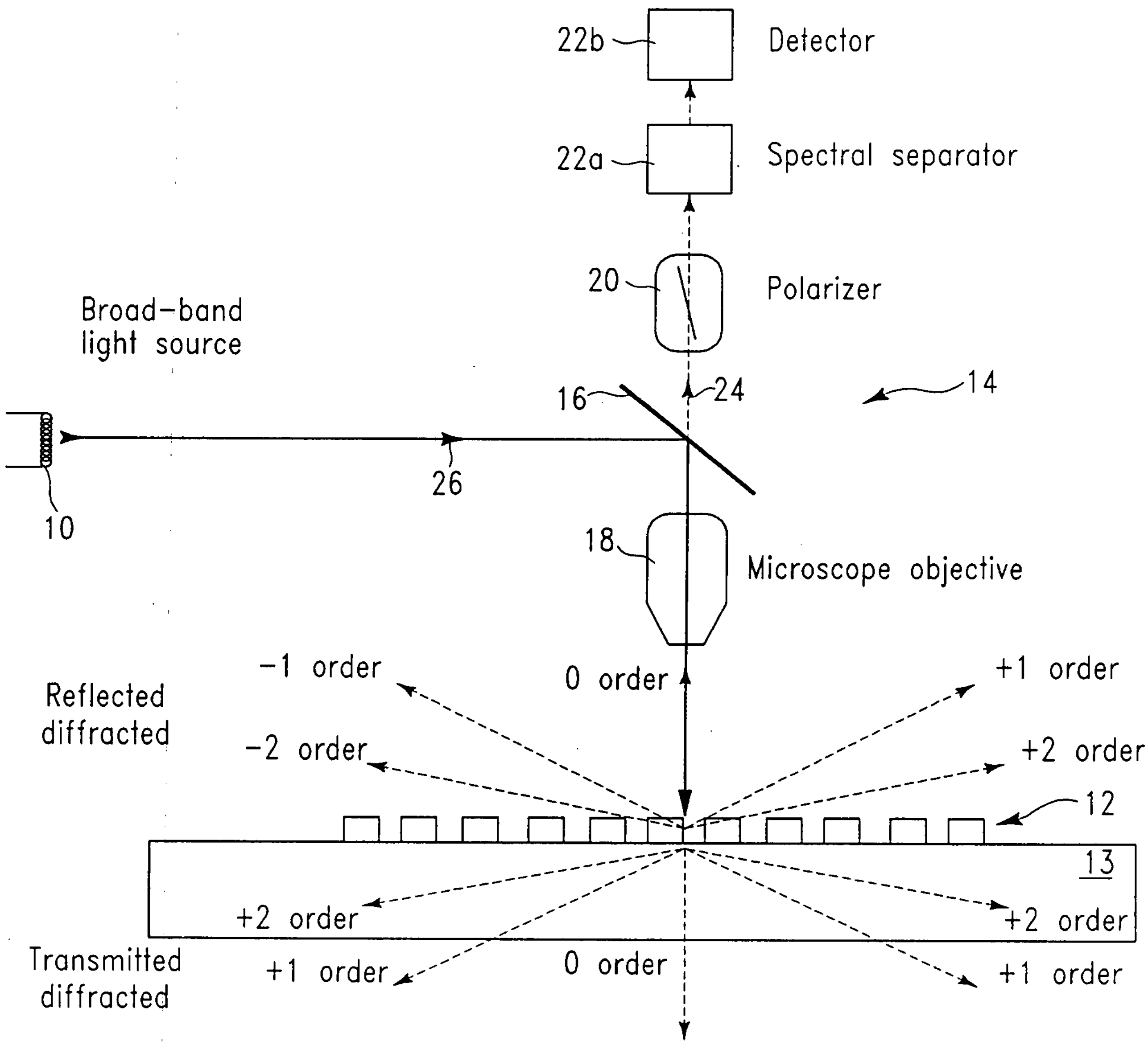

22b
Detector
22a
Spectral separator
20
Polarizer
Broad-band
light source
16
24
14
26
10
18
Microscope objective
-1 order
0 order
+1 order
Reflected
diffracted
-2 order
+2 order
12
13
+2 order
+2 order
Transmitted
diffracted
+1 order
0 order
+1 order

FIG. 9

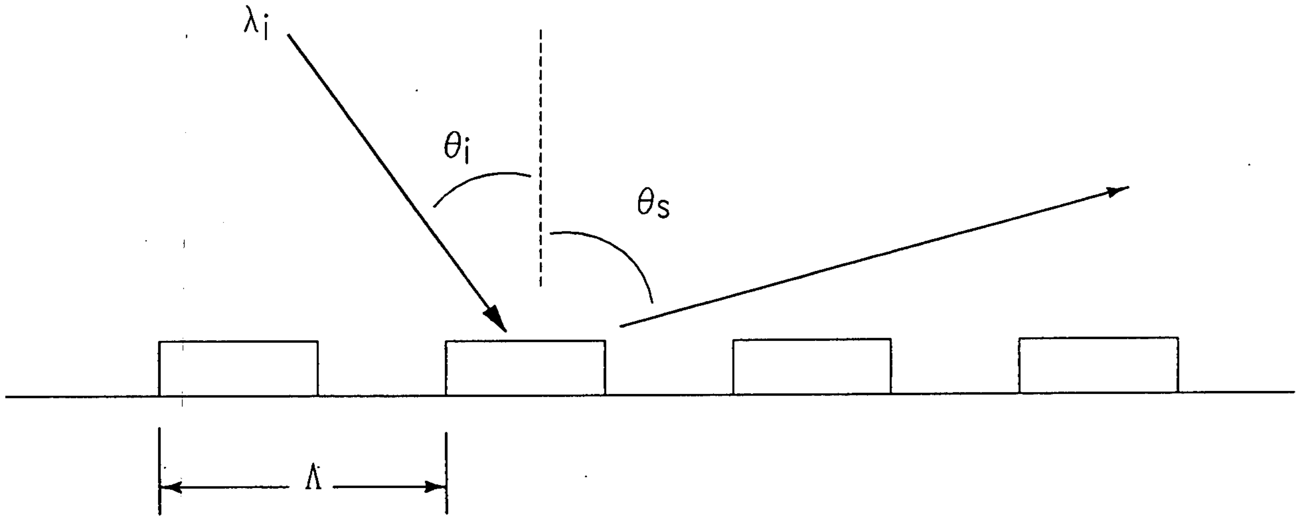
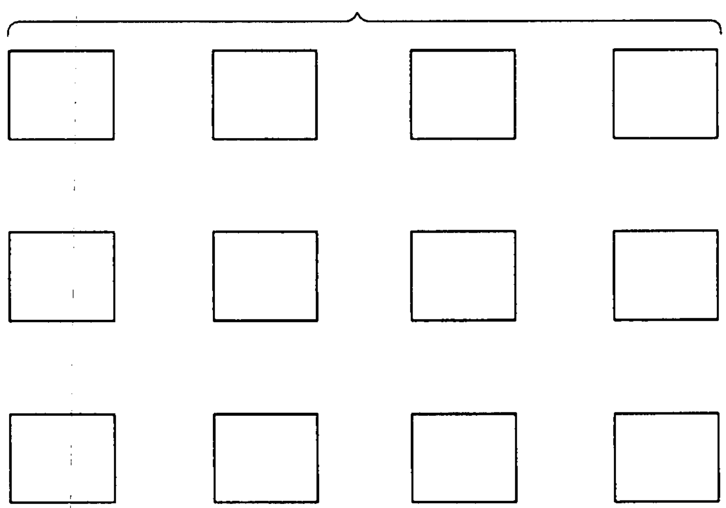


FIG. 10

FIG. 13a



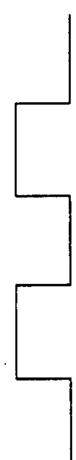


FIG. 13c

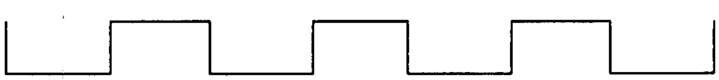


FIG. 13b

```
 COUPLEDWAVE WL;TT;DD
⍝  Set ORDERS = the number of ±diffracted orders retained.
 WAVELENGTH←WL
 f←LAYER[;2]÷GRATINGPERIOD      ⍝ Determine f from dimensions
 d←LAYER[;3]                    ⍝ Layer thicknesses
 n0←1                           ⍝ Index of air
 THETA←TH                       ⍝ Angle of incidence, degrees
 THET←THETA×○1÷180              ⍝ Incidence angle, radians
 ns←SIINDEX WAVELENGTH          ⍝ Determine the substrate index
 n←0⍴0
 FILMINDEX¨LAYER[;1]            ⍝ Determine the FILM index
 N←1+ORDERS×2                   ⍝ N will always be odd
 h←(⍳N)-1                       ⍝ h is  0 1 2 3 4 5 6 7...
 i←h-((N-1)÷2)                  ⍝ i is  ...¯3 ¯2 ¯1 0 1 2 3...
 I←,DD←(N,N)⍴0
 TT←(N,N)⍴⍳N
 I[(0=,(TT-⍉TT))/⍳N*2]←1
 I←(⍴f)⍴⊂(⍴DD)⍴I                ⍝ I is the identity matrix
 IL←1⊃I
 k0←○2÷WAVELENGTH
 kxi←k0×(n0×1○THET)-i×WAVELENGTH÷GRATINGPERIOD
 k1zi←((-(TT<0)×2)+1)×(TT←((k0*2)×(n0*2))-(kxi*2))*.5
 k2zi←(((k0*2)×(ns*2))-(kxi*2))*.5        ⍝ Absorbing substrate (Si)
TM:
 B←((K+.×¨(EE←⌹¨E←PERMITTIVITY))+.×¨K←WAVENUMBER)-¨I
⍝DERTM←0
⍝→TE
 EIGENSTUFF E+.×¨B             ⍝ TM eigenspace calculations
 V←(EE+.×¨W)+.×¨Q              ⍝ PRODUCT MATRIX FOR   TM  (EE IS ⌹¨E)
 X←I×¨*-k0×¨Q×d                ⍝ d SCALAR OR VECTOR WITH LENGTH OF f
 DELTA←((2×N),1)⍴(i=0),((2○THET)×0J1÷n0)×i=0        ⍝ FOR TM
 Z1←(1⊃I)×(N,N)⍴k1zi÷((n0*2)×k0)
 Z2←(1⊃I)×(N,N)⍴k2zi÷((ns*2)×k0)
 M1←IL,[1]-0J1×Z1
 FG←(1⊃I),[1]0J1×Z2
 FANDG¨⌽⍳⍴f
 R←N↑,(-DELTA)⌹(M1,-FG)
⍝     Diffraction efficiency for TM
 DERTM←(THETAOUT=TH)/(DERTM≠0)/DERTM←(R×+R)×9○(k1zi÷k0×n0×2○THET)
⍝ DERTM←(DERTM≠0)/DERTM←(R×+R)×9○(k1zi÷k0×n0×2○THET)
⍝
 DERTE←0
 →COMB
TE:
```

FIG. 11a

```
[44]  A←(K+.×¨K)-¨E
[45]  EIGENSTUFF A                  ⍝ TE eigenspace calculations
[46]  V←W+.×Z¨Q                     ⍝ PRODUCT MATRIX FOR   TE
[47]  X←I×¨*-k0×¨Q×d                ⍝ d SCALAR OR VECTOR WITH LENGTH OF f
[48]  DELTA←((2×N),1)⍴(i=0),((2○THET)×0J1×n0)×i=0         ⍝ FOR TE
[49]  Y1←(1⊃I)×(N,N)⍴k1zi÷k0
[50]  Y2←(1⊃I)×(N,N)⍴k2zi÷k0
[51]  M1←IL,[1]-0J1×Y1
[52]  FG←(1⊃I),[1]0J1×Y2
[53]  FANDG¨⌽⍳⍴f
[54]  R←N↑,(-DELTA)⌹(M1,-FG)
[55] ⍝         Diffraction efficiency for TE
[56]  DERTE←(THETAOUT=TH)/(DERTE≠0)/DERTE←(R×+R)×9○(k1zi÷k0×n0×2○THET)
[57] COMB:
[58]  CURVE←CURVE,[1]1 3⍴WAVELENGTH,DERTE,DERTM
[59] ⍝CURVE←CURVE,[1]1 3⍴WAVELENGTH,DERTM,DERTE

[0]   EIGENSTUFF EI
[1]   Z←EIGEN¨EI         ⍝ The function EIGEN is an IBM program product
[2]   W←((⍴f)⍴⊂1 0)↓¨Z  ⍝ and cannot be shown here.
[3]   QQ←((⍴f)⍴⊂((-N),0))↓¨Z
[4]   Q←0⍴0
[5]   EIGENVALUE¨QQ
[6]   Q←Q×¨I

[0]   EIGENVALUE QQ
[1]   Q←Q,⊂(N,N)⍴QQ*.5

[0]   FANDG L;XA;XL;WL;VL
[1]   XL←L⊃X
[2]   WL←L⊃W
[3]   VL←L⊃V
[4]   AB←(⌹((-WL),[1]VL),FG)+.×(WL+.×XL),[1]VL+.×XL
[6]   A←(N,N)⍴AB
[7]   FG←(WL+.×IL+XA),[1]VL+.×IL-XA←XL+.×A

[0]   FILMINDEX FILM;C1;C2;C3;I
[1]   I←(20=+/¨((⊂FILM)=CAUCHY[;1]))/⍳1↑⍴CAUCHY
[2]   C1←CAUCHY[I;2]
[3]   C2←CAUCHY[I;3]
[4]   C3←CAUCHY[I;4]
[5]   n←n,C1+(C2÷(WAVELENGTH×10)*2)+C3÷(WAVELENGTH×10)*4
```

FIG. 11b

```
[0]   E←PERMITTIVITY
[1]   E←0ρ0
[2]   PERMPRIME¨ιρf

[0]   PERMPRIME M
[1]   PP←(N,N)ρh+1
[2]   II←⍉PP
[3]   EE←,((n[M]*2)-(n0*2))×(1○(○1×(II-PP)×f[M]))÷○1×II-PP
[4]   EE[(0=,(II-PP))/ιN*2]←((n[M]*2)×f[M])+(n0*2)×(1-f[M])
[5]   E←E,⊂(ρII)ρEE

[0]   K←WAVENUMBER
[1]   K←(N,N)ρk×i÷k0
[2]   K←(⊂K)×¨I

[0]   ns←SIINDEX WAVELENGTH;INDEX;A;ks
[1]  ⍝ Determine the complex refractive index from 210 to 825 nm.
[2]   INDEX←¯1+2↑(WAVELENGTH≤SI[;1])/ι1↑ρSI
[3]   ns←SI[INDEX[1];2]+(A←(WAVELENGTH-SI[INDEX[1];1])÷-/SI[INDEX;1])
×-/SI[INDEX;2]
[5]   ks←SI[INDEX[1];3]+A×-/SI[INDEX;3]
[6]   ns←ns-0J1×ks
```

FIG. 11c

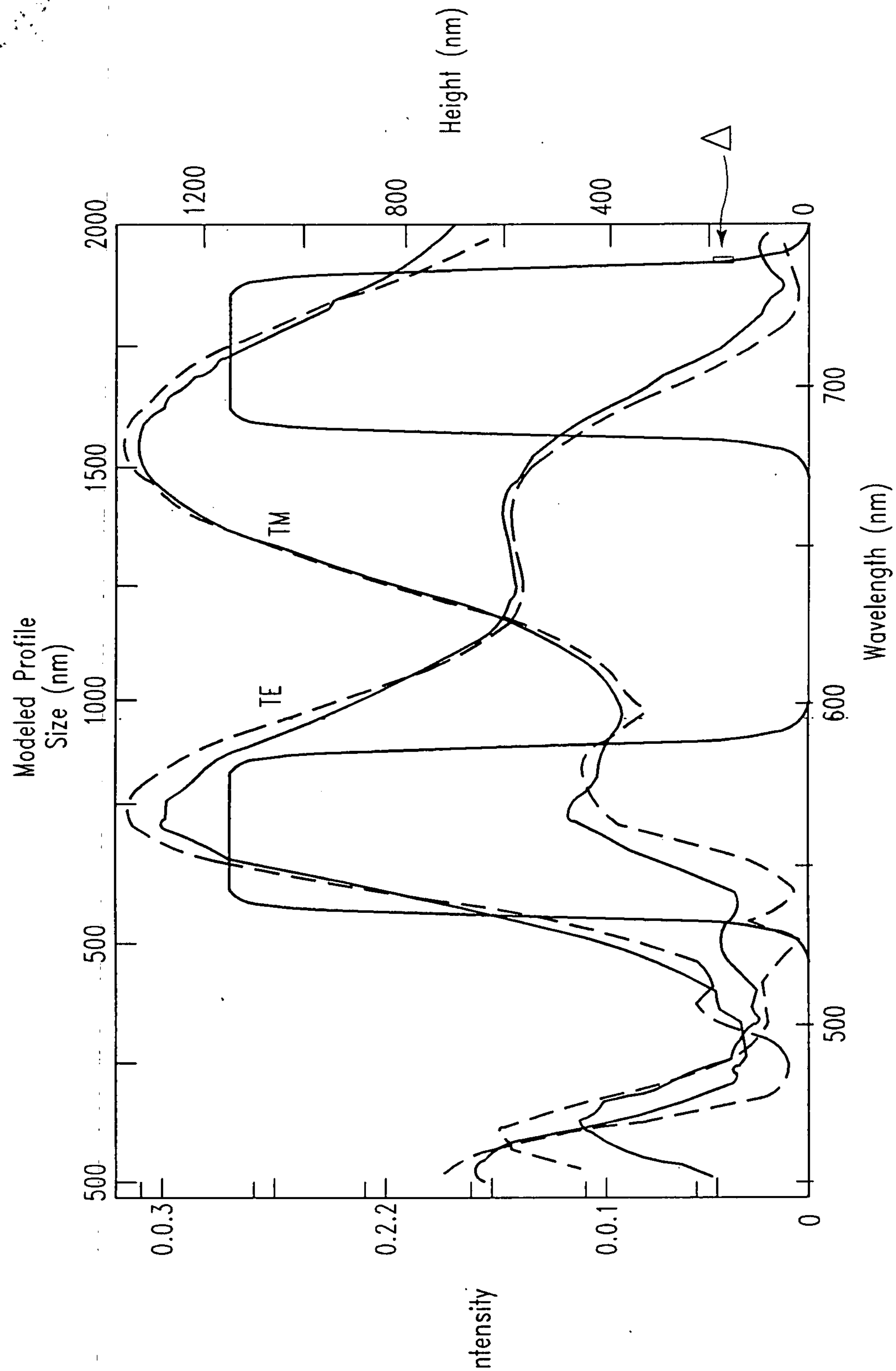

Height (nm)
1200
800
400
0
2000
1500
1000
500
500
Modeled Profile
Size (nm)
TM
TE
Wavelength (nm)
700
600
500
0.0.3
0.2.2
0.0.1
0
Intensity

FIG. 12

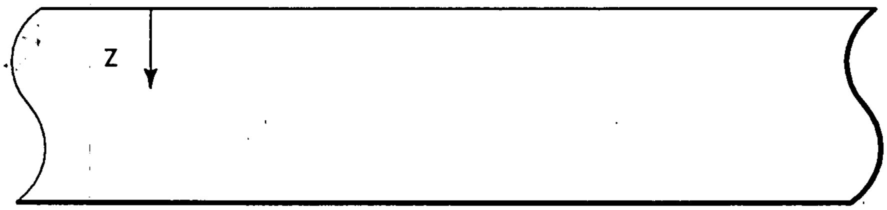


FIG. 14a

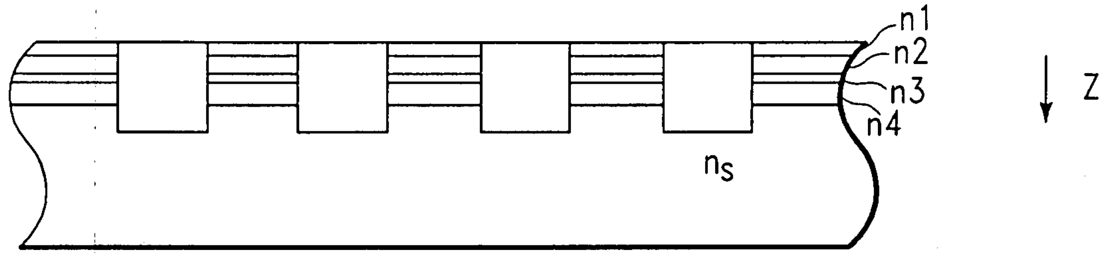


FIG. 14b

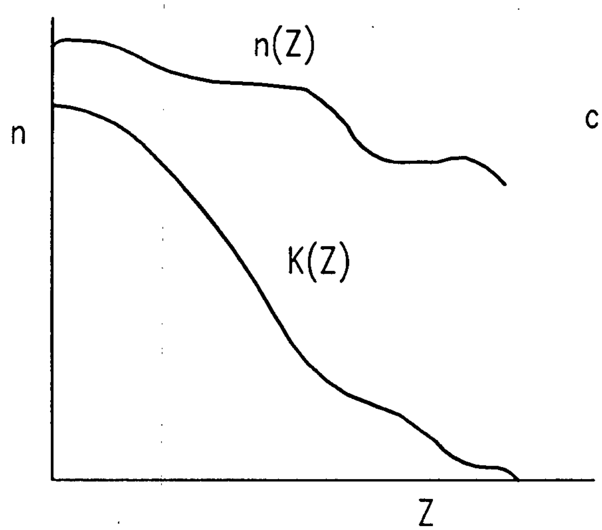


FIG. 14c

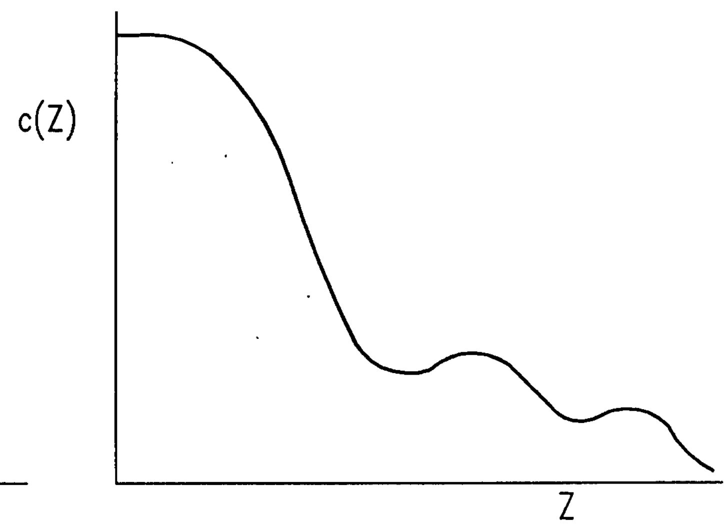


FIG. 14d

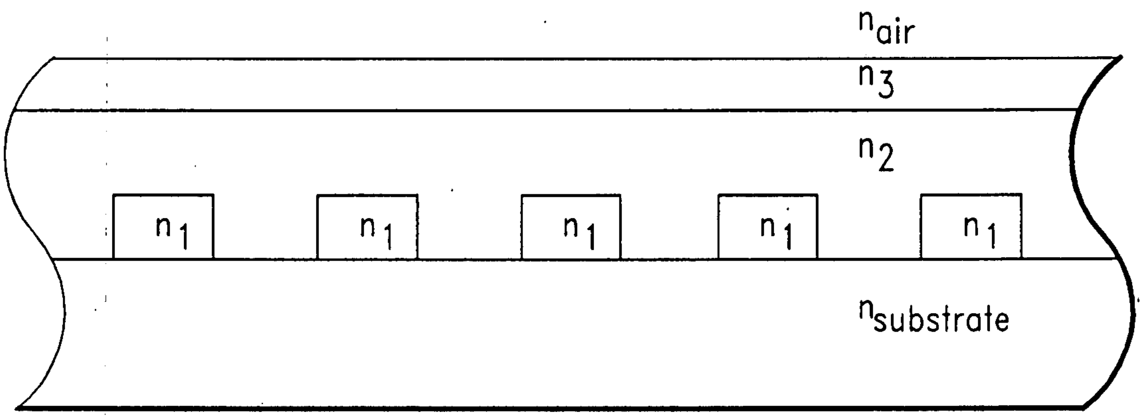


FIG. 15